Redesigning the Tomato for Mechanized Production

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A redesigned tomato plant and its fruit have played a highly significant part in streamlining the mechanization of tomato production, harvesting, and handling.

Development of tomato varieties suited to mechanized harvesting was concurrent with harvester design and development. G. C. Hanna and associates at the University of California, Davis, first conceived the idea that tomatoes would some day be harvested by machine. In 1947, Hanna began developing a variety able to withstand the rigors of machine harvesting and bulk handling.

Early efforts indicated no current variety possessed the relatively small-vine stature, concentrated fruit set and ripening period, and pliability of fruit needed to pass through a machine with little or no fruit breakage. Fruit of the large-vined variety, San Marzano, withstood simulated machine harvesting and was used as a parent in combination with early-maturing, soft-fruited, small-vined varieties. The small pear-type variety, V Red Top–9, was developed. Though of little commercial value, it was useful in performance trials of the machine.

By 1959, Hanna had developed for simulated harvest by machine numerous strains sufficiently uniform in vine type, concentrated profuse fruit set, maturity, resiliency of fruit, quality characteristics, and ability to "hold" for 30 days or more on the vine without deterioration. A large number of these were harvested by the prototype mechanical harvester in 1960.

From similar trials with the harvester in 1961, varieties, VF 145A and VF 145B, were released to seedsmen and growers. These two varieties, and subsequently selected varieties, are the foundation on which California tomato growers of about 180,000 acres have been able to almost entirely mechanize harvesting and handling of the crop.

Strains of the VF 145 group and the variety with elongated fruit, VF 13L, released in 1963, comprise almost 90 percent of the acreage planted to tomatoes in California in 1967.

A few years after Hanna started working on varieties that might be mechanically harvested, C. Lorenzen of the University of California initiated work on a tomato harvester. By 1962, both the machine and the plant were ready to go. Subsequently, the U.S. Government in 1964 refused to extend the provision of Public Law 78 by which foreign nationals were allowed to come into this country to help with crop production and harvesting.

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As a result, tomato harvesting machines became all important almost overnight. The harvested acres of tomatoes for processing, which had dropped more than 20 percent in 1963 due primarily to a labor shortage prediction, began to regain these losses and to show some increase. By 1966, the tomato harvester had eliminated about 3.5 million man-hours of labor annually.

There is considerably more to mechanizing tomato production than just the harvester. Like all crops that are successfully mechanized, the real success of the project must go back to the plant, and indeed, even back to the seed from which the plant comes and the soil in which it grows. Machines are not made to harvest crops; in reality, crops must be designed to be harvested by machines.

It is the plant breeder, working with the engineer and many other agricultural scientists, that makes for a completely mechanized crop production system. There are few instances of completely mechanized crops where breeding and cultural practices have not had a hand in the venture's success. And there are no instances where the system cannot be improved upon by a step-by-step analysis and evaluation of each variable in the system by all branches of agriculture that are concerned.

Generally, the pressure is almost wholly on the engineer at the start to design a machine to harvest a given crop. However, in the case of tomatoes, Hanna had foreseen the need for tomato varieties that would lend themselves to mechanical harvesting and handling several years prior to any design work on the harvester. He envisioned a small, tough-skinned tomato whose plant would "set" a majority of its fruit over a short period of time, but that would hold the fruit

Prof. G. C. Hanna of University of California, developer of tomato variety VF 145. This is first and still most popular machine-harvestable tomato variety.

Harvesting tomatoes and loading them into bulk bins on a tractor-drawn trailer.

while waiting for harvest. To a remarkable extent, these goals have been accomplished although, as with all crops, improvements will continue.

Nor has quality been forgotten during this period. Today there are many plant breeders crossing and recrossing lines to produce that one perfect product. Such a perfect product is a goal and is not envisioned in the immediate future. However, in the newer varieties, breeders have maintained at a high level such quality factors as flavor, color, acidity, and product properties. Improvements are anticipated in the overall quality of tomatoes and their products that will be measured with more sophisticated equipment and techniques. Thus, fruit from large numbers of breeding lines will be rapidly evaluated for the many traits that influence quality and consumer acceptance.

Breeders and horticulturists alike have had a hand in increasing yields. In 1940, the average yield of tomatoes for processing in California was between 6 and 7 tons per acre. More prolific strains and better fertilization and cultural practices have raised this average to over 20 tons per acre, and fields that yield over twice that much are not uncommon.

In commercial practice today, fields are largely planted with seed directly and generally thinned to the desired plant spacing. However, there are some cases when precision seeding has minimized the need for extensive thinning.

The seedbed must be carefully prepared to avoid clods, allow for irrigation, and present a level bed under the plant for best harvesting results.

Plant population is a major factor affecting yield. In some California studies, 30,000 to 50,000 plants per acre have given good results although many plantings are in single rows 4½ to 5 feet wide, spaced 6 to 9 inches in the row, resulting in populations of 12,000 to 20,000 plants per acre. Twin-row production, or the planting of two rows close together, requires more precision and closer management; however, the results of skips and blank areas are minimized, giving a better utilization of cropland. This method is usually recommended where soil and weather conditions account for smaller plants.

Fertilization and irrigation are important for successful mechanization of the harvest. Both materially affect the "machinability" of the crop, bulk handling capability of the fruit, and the quality of the product for processing. Growers have learned the need of a fertilization program based on an extensive soil-testing program.

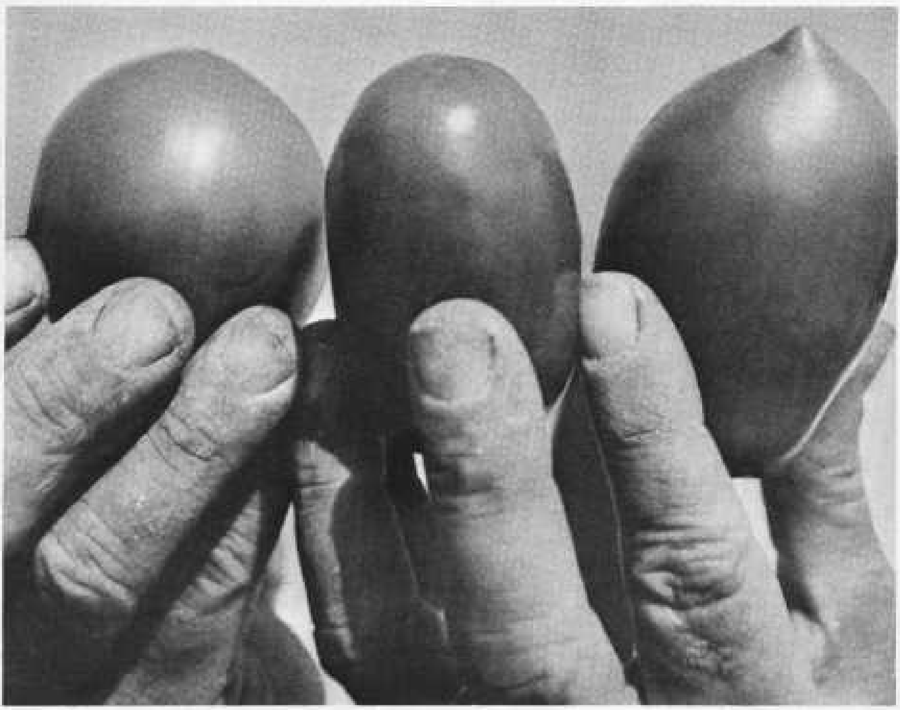
All the phosphorus and potash where needed are either spread uniformly on the soil surface and worked in as the soil is prepared for planting or placed in the early active root zone at planting time. Nitrogen is either applied at seeding time or a portion applied then and the remainder in a band below the soil surface and between the rows just prior to plant thinning. This program of fertilization insures an optimum supply of nutrients for early seedling vigor and continuous growth through the fruit setting and subsequent development period. An oversupply of nutrients, particularly of nitrogen, will cause excessive vine growth, cyclic setting and ripening periods, lower fruit quality, and will increase certain fruit disorders.

Irrigation practices have been developed that insure continuous growth of the tomato seedlings through the fruit-setting stage. Once the crop potential has been established, irrigation is used only to size the fruit and maintain plants in a healthy condition until 3 to 5 weeks before harvest.

Through this general procedure, growers have been able to maximize the percentage of ripe fruit in a harvestable condition at the time the field is scheduled for picking.

Handling tomatoes from the harvester and transfer to over-the-road trucks still constitutes a production bottleneck. Lugs that held approximately 30 pounds each and served as picking containers, as well as containers for over-the-road transportation, are no longer economically feasible. Even pallet boxes holding approximately 25 lugs that are transferred from field conveyances to over-

Machine harvestable tomatoes developed by USDA.



Tomato planting operations done simultaneously—planting beds are formed, fertilizer applied, seed precision-planted, and a weed control chemical applied.

the-road transportation are being replaced by over-the-road trucks that are field going also. There is less handling of the individual tomato by this method, and transfer stations are no longer needed. The firm, tough-skinned tomatoes, a product of advanced breeding developments, take such treatment with little damage so long as the proper depth allowances in the container are not violated and hauling distances are not too great.

And yet tomato harvesting machines and techniques are still in their infancy. Improved machines are coming off the assembly line each year. In 1966, some 800 machines picked almost 70 percent of the California crop. With four major manufacturers now producing machines, and others entering the field so fast it is hard to keep up with them, it is expected that more than 80 percent of tomatoes grown in the United States for processing will be harvested by machine in 1968.

Still, the job is far from finished. When tomatoes start coming off these machines in such profusion, bottlenecks occur which were never dreamed of when the bracero (imported fieldworker) was spending long backbreaking hours at this dirty, menial, and seasonal task. Moving the tomatoes from the harvester, transporting them to the processing plant, and handling the increased volume at the plant over a shorter period of time are examples of problems that have yet to be solved. Add to this machinery breakdowns and newly introduced cultural practices which are parts of the same problem and you get a picture of a new concept in farm production requiring laborers with higher skills, entirely new lines of machinery, and growers who are not just agriculturists, but farm managers in every sense.

So, with the momentous start that has been made toward streamlining tomato production and harvesting through the foresight of two investigators at the University of California in the late forties and early fifties, immeasurably helped by a labor shortage and a demand for increased production, necessity has again become the mother of invention.

With these developments have come problems as well as benefits that will employ the best minds of plant breeders, horticulturists, and engineers for many years to come.